REMARKS

Claim Status

In view of the above, claims 1-57 are pending. Claims 1, 43, 44, 45, 46, 47, 48, 49, 50, 51, and 54 are independent claims. Claims 56 and 57 are new.

Claims Objections

The action objects to claims 4, 5, 24, 31, and 53 for various informalities. We believe we have addressed these informalities by amendment. We also note that recitation of "multiple locations of the test object" at line 2 of claim 5, provides antecedent basis for "the multiple locations" at line 3 of claim 5.

Section 112 Rejections

The claims have been amended to replace the offending expression "complex reflexity" with the correct expression "complex reflectivity." We thank the Examiner for identifying this typographical error.

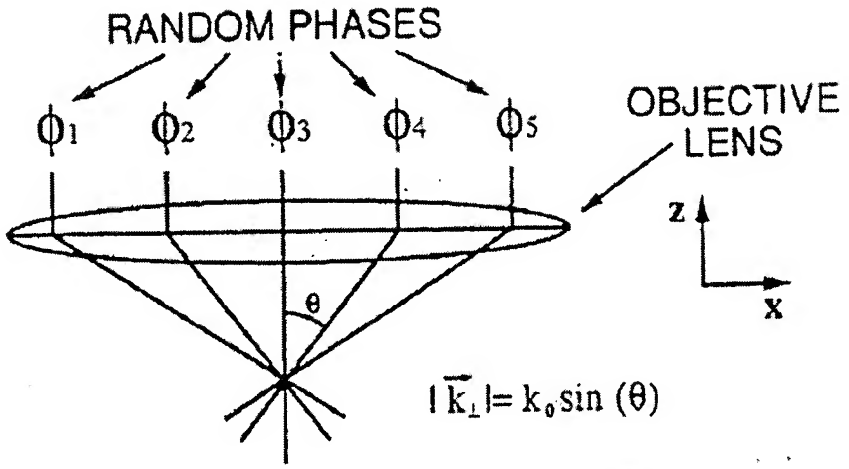
Prior Art Rejections

The action alleges that claims 1-7, 10-12, 20, 21, 35, and 54 are anticipated by U.S. Patent No. 5,112,129 ("Davidson"). The action further alleges that claims 8, 9, 13-18, 22, 24-26, 29, 30, 34, 36-38, and 42, all of which depend from independent claim 1, are obvious over Davidson in view of one or more secondary references. We traverse.

With respect to Davidson, the Examiner states:

> "Davidson discloses a device that images light from a source onto a test object over a range of angle to interfere with reference light on a detector... An *angle dependence is determined* of an optical property of the test object based on the interference between the test and reference beams of light (see Figure 3) as the optical path length difference is varied by the scanning of the piezoelectric vertical motion system." (Office action at 3-4, emphasis added.)

In support of this statement, the Examiner reproduces the following portion of Davidson, Figure 3:



While this Figure does depict light passing through an objective lens at various angles, it does not disclose determining an *angle dependence* of an optical property of a test object, as alleged in the action.

To the contrary, Davidson is directed toward a coherence probe microscopy technique for determining the *mutual coherence* of a reference beam and a probe beam superimposed on a detector. (See, e.g., Davidson column 4, lines 35-37). Davidson shows how such mutual coherence is calculated in the remaining portion of Figure 3, shown below:

$$\vec{E}(x,z,t) = \int \frac{d^2\vec{k}_\perp}{(2\pi)^2} e^{i\vec{k}_\perp\cdot\vec{x} + ik_z z - i\omega t} \sum_{\lambda=1}^{2} \vec{e}_\lambda(\vec{k}) E_\lambda(k_\lambda) \times$$

$$\times e^{i\phi_\lambda(\vec{k}_\perp)} \theta((NA\cdot k_0)^2 - \vec{k}_\perp^{\,2})$$

$$\text{where } \omega = c|k_0|;\ k_z = \sqrt{k_0^2 - k_\perp^2}$$

RANDOM PHASE APPROXIMATION:
(ASSUMES UNPOLARIZED LIGHT)

$$\langle e^{i\phi_\lambda}(k_\perp) e^{-i\phi_{\lambda'}}(k_\perp')\rangle = \delta^2(\vec{k}_\perp - \vec{k}_\perp')\delta_{\lambda,\lambda'}$$

MUTUAL COHERENCE:

$$\langle \vec{E}(x,z,t)\cdot\vec{E}(0,0,t)\rangle = \int d^2\vec{k}_\perp e^{i\vec{k}_\perp\cdot\vec{x} + ik_z z} \sum_{\lambda=1}^{2} E_\lambda^2(\vec{k}_\perp)$$

IF THE PUPIL IS UNIFORMLY FILLED, THEN:

$$E_\lambda^2 = \theta((NA\cdot k_0)^2 - k_\perp^2)$$

SO UP TO A MULTIPLICATIVE CONSTANT WE HAVE:

$$\langle \vec{E}(x,z,t)\cdot\vec{E}(0,0,t)\rangle = \int d^2\vec{k}_\perp e^{i\vec{k}_\perp\cdot\vec{x} + ik_z z}\ \theta((NA\cdot k_0)^2 - k_\perp^2) = G(x,z)$$

WHERE THE FUNCTION G IS COINCIDENTALLY
THE SAME AS THE COHERENT IMPULSE
RESPONSE FUNCTION AT Z = 0.

Fig. 3

Note that the Davidson device does not actually perform this calculation, it is presented only as part of an explanation of the theory underlying coherence probe microscopy (Davidson, column 4, line 22 – column 5, line 59). As shown in the above portion of Figure 3, mutual coherence is an *angle independent* quantity which arises from a *superposition* of light waves incident from multiple angles passing through an objective lens. This superposition is represented in the calculations above by integration over all possible wave vectors k (and thus all possible incident angles). Some confusion may arise from that the appearance of the bold-faced character θ in

formulae above. However, the bold-faced θ does not refer to a physical angle, but is instead a representation of the Heaviside step function[1]. The term

$$\theta((NA \cdot k_o) - k^2{}_\perp),$$

where NA is the numerical aperture of the objective lens, only serves to limit the integrations to those wave vectors (and thus incident angles) which actually pass through the lens and are imaged on a detector. Performing this integration removes any angular dependences. Thus, the theoretical background presented in Davidson shows that mutual coherence has *no angular dependences whatsoever.*

Accordingly, we submit that independent claim 1 patentably distinguishes Davidson because it recites "determining an angle-dependence of an optical property of the test object." In contrast, Davidson determines mutual coherence which is, as shown above, an angle *independent* quantity. Therefore, we ask the Examiner to withdraw the rejection of independent claim 1.

Furthermore, we submit that claims 2-42, which depend from independent claim 1, patentably distinguish Davidson for at least the same reasons as those above. Therefore, we ask the Examiner to withdraw the rejections of those claims as well.

Independent claim 54 also stands rejected as allegedly anticipated by Davidson. We traverse.

Claim 54 recites "a source module configured to illuminate the test object with substantially collimated light" (emphasis added). Embodiments within the scope of this claim are disclosed in applicant's specification at page 18, line 4, through page 19, line 2. For example, the specification states "the scanning interferometry system may be used to illuminate a test sample with test [light] incident over only a very narrow range of incident angles (e.g., substantially normal incidence or otherwise collimated), which may then be scattered or diffracted by the test sample" (page 18, lines 6-9.)

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[1] The Heaviside step function is a discontinuous function which returns a value of 1 for positive arguments, a value of 0 for negative arguments, and a value of ½ for a zero argument .

The Examiner states that Figure 1 in Davidson shows "a source module (lamp, condenser lens, filters, diffuser, aperture stop, and final collimating lens) configured to illuminate the test object with collimated light." (Office action at 5.) However, this figure shows an objective lens positioned between the so called "final collimating lens" and the test object. This objective lens is shown focusing light onto the test object from a wide range of angles of incidence – accordingly the test object is being illuminated with *non-collimated* light. In contrast, independent claim 54 recites "a source module configured to illuminate the test object with substantially collimated light." Accordingly, we ask the Examiner to withdraw the rejection of independent claim 54.

Independent claims 44-46, 48, and 49 stand rejected as being allegedly anticipated by U.S. Patent No. 4,999,014 ("Gold"). Specifically, the examiner states that "Gold discloses a device that determines an angle-dependence of an optical property...of a test object...based on *interferometry data* for the test object in the form of angular dependent intensity measurements (Gold, Abstract, lines 7-13)." (Office action at 6, emphasis added). We traverse.

We respectfully submit that Gold does not disclose a device that determines angle dependence of an optical property based on interferometry data as alleged by the action. To the contrary, with regard to his disclosure Gold states:

> "An apparatus for measuring the thickness of a thin film layer on substrate [that] includes *a probe beam* of radiation focused substantially normal to the surface of a sample using a high numerical aperture lens. The high numerical aperture lens provides a large spread of angles of incidence of the rays within the incident focused beam. A detector measures the intensity across the *reflected probe beam* as a function of the angle of incidence.... A processor functions to derive the thickness of the thin film layer based on these angular dependent intensity measurements." (Abstract, lines 1-13, emphasis added.)

Accordingly, Gold only discloses the measurement of a probe beam intensity. There is no measurement of interferometric data. For example, the probe beam is not overlapped with any kind of reference beam to create an interference signal, nor does one portion of the probe beam interfere with another portion of the probe to produce such a signal.

Thus, we submit that claims 44, 45, 46, and 48 patentably distinguish Gold. For example, claim 44 recites "determining an angle dependence of an optical property of a test

object based on scanning interferometry data for the test object," and claim 45 recites "determining a thickness of a thin film on a test object comprising the thin film and a substrate supporting the thin film based on monochromatic scanning interferometry data for the test object." As discussed above, no such interferometry data is disclosed in Gold, thus no determination of angle dependence or thickness can be made based on the claimed "interfermometry data." Similarly, claims 46, 48, and 49 disclose apparatuses comprising either a "scanning interferometer" or a "scanning interferometry system" and so likewise distinguish Gold. Accordingly, we ask the Examiner to withdraw the rejection of independent claims 44-46, 48, and 49.

Independent claims 43 and 47 stand rejected as allegedly obvious over Davidson in combination with De Groot (USPN 5,398,113). With regard to these claims, which both recite the use of a monochromatic source, the examiner states:

> "The device of Davidson does not disclose the use of a monochromatic light source. The device of Davidson can be used to find the thickness of a thin film as a test object. De Groot discloses the use of a narrow band (i.e. monochromatic and point) source in an interferometry device when testing a device of unknown composition.... Therefore, it would have been obvious to one skilled in the art at the time the invention was made to use the narrow band source of de Groot in Davison's device...." (Office Action at 8.)

We traverse.

We respectfully submit that one skilled in the art would not modify Davidson to use a monochromatic light source because such a modification would render the device inoperable. Specifically, Davidson teaches the use of coherence probe microscopy to determine the thickness of a test object. (Davidson, column 2, lines 65-68). A coherence probe microscope determines differences in optical path length between a reference beam and a measurement beam by measuring the degree of fringe contrast when the beams are overlapped. As explained in Davidson, this type of measurement is only sensitive to differences in optical path length if the light used has a limited coherence length:

> "In a two-beam interference microscope...a light wave from a source 31 reaching the image plane 36 is the sum of two constituent waves; one reflecting off the surface of the object 16, and the other reflecting off the surface of a reference mirror 34. Fringes are seen in the image at 36, even when white light is used to illuminate the object. If broad

> band illumination (white light) is used, strongest fringing occurs when the path difference between the reference channel 32 and the object channel 30 is very small, on the order of a fraction of the average wavelength, *because the coherence length of white light is very short.* When the degree of coherence is high between the reference channel and the object channel, the fringes are strong. Conversely, when the degree of coherence is low, the fringes are weak." (Davidson column 3, line 58 to column 4, line 5).

Thus, as the coherence length of the light used in the microscope decreases so does the ability of Davidson device to determine differences in optical path length. If a monochromatic (and thus highly coherent) light source is used, the device is rendered insensitive to changes in optical path length, and therefore becomes incapable of determining the thickness of a test object.

De Groot actually reiterates this point: "it is well understood that if the source light for the interferometer is essential[ly] monochromatic...it is not generally possible to accurately measure surface features... ."(De Groot, column 1, lines 19-24.)

Accordingly, we submit that the proposed modification of Davidson must fail, and ask the Examiner to withdraw the rejection of independent claims 43 and 47.

Independent claim 50 stands rejected as allegedly obvious over Davidson in view of U.S. Patent No. 6,721,094 ("Sinclair"). The Examiner concedes that Davidson fails to disclose the claimed "at least one polarization optic positioned in a pupil plane of the objective," but alleges that it would be obvious to use the quarter wave plate 46 in Sinclair as the claimed polarization optic. (Action at page 9.) We traverse.

Even assuming, for the sake of argument only, that there is motivation to modify Davidson according to Sinclair, something we do not concede, the quarter wave plate 46 in Sinclair is <u>not</u> positioned in the pupil plane of the objective, as required by the claim. To the contrary, Figure 4 in Sinclair shows quarter wave plate 46 *spaced* from pupil plane 19. Specifically, plane 19 is the back-focal plane of objective 12 in the sample arm. (See, for example, Sinclair at col. 7, lines 1-6.) Accordingly, we ask the Examiner to withdraw the rejection.

Allowable Claims

We thankfully acknowledge the Examiner's indication that claims 19, 23, 27, 28, and 51 would be allowable if rewritten in independent form. However, because we believe the independent claims from which they depend patentably distinguish the cited prior art, we have not rewritten them to be independent form at this time.

Conclusion

In view of the above, we ask that all claims be allowed.

Canceled claims, if any, have been canceled without prejudice or disclaimer.

Any circumstance in which the applicant has (a) addressed certain comments of the examiner does not mean that the applicant concedes other comments of the examiner, (b) made arguments for the patentability of some claims does not mean that there are not other good reasons for patentability of those claims and other claims, or (c) amended or canceled a claim does not mean that the applicant concedes any of the examiner's positions with respect to that claim or other claims.

Enclosed is a $100.00 check for excess claim fees and a $120.00 check for the Petition for Extension of Time fee. Please apply any other charges or credits to deposit account 06-1050, referencing 09712-332001.

Respectfully submitted,

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